

Comparison of Two Integrated Groundwater-Surface Water Simulation Frameworks for Irrigated Food Production in Highly Developed Water Management Regions



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Abstract

To meet water-resource managers' need for a holistic water management approach, integrated, highly complex numerical models representing multiple hydrologic components are often developed. Numerical models commonly represent one component of the hydrologic cycle with substantial process detail (e.g., groundwater basin flow, watershed surface flow, vadose zone flows), but use highly simplified approaches for other components of the hydrologic cycle. In California, two of the most frequently used groundwater numerical models are the MODFLOW One-Water Hydrologic Flow Model (MF-OWHM) developed by the U.S. Geological Survey and the Integrated Water Flow Model (IWFM) developed by the California Department of Water Resources. Both models simulate transient state large scale groundwater basins at high resolution, and are executable on modern day computer systems.

The California Central Valley (CV) groundwater basin and its overlying watershed provide a comprehensive case study to compare these models and their application to the CV, given CV's leading U.S. specialty crop and dairy food production, extensive water infrastructure development, and position as one of the three largest U.S. groundwater systems. Applications of MF-OWHM and IWFM to the CV, CVHM2 and C2VSIM form the basis for the development and implementation of Groundwater Sustainability Plans (GSPs). Here, we present a comparison of CVHM2 and C2VSIM with a focus on the groundwater budgets, stream aquifer-interaction and water allocations for agriculture and urban areas. The important differences and similarities between the two models are highlighted

Integrated hydrologic models for comparison

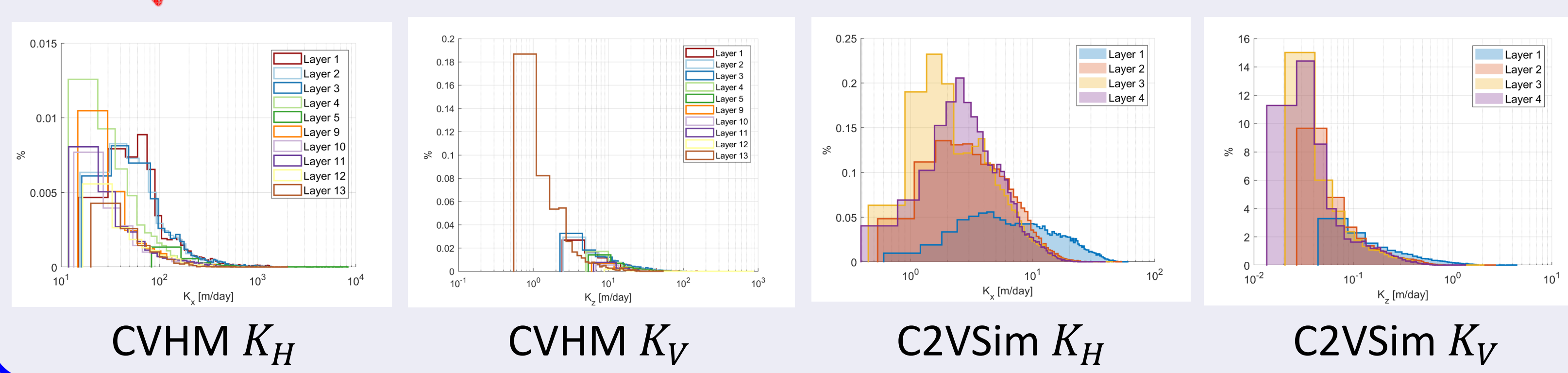
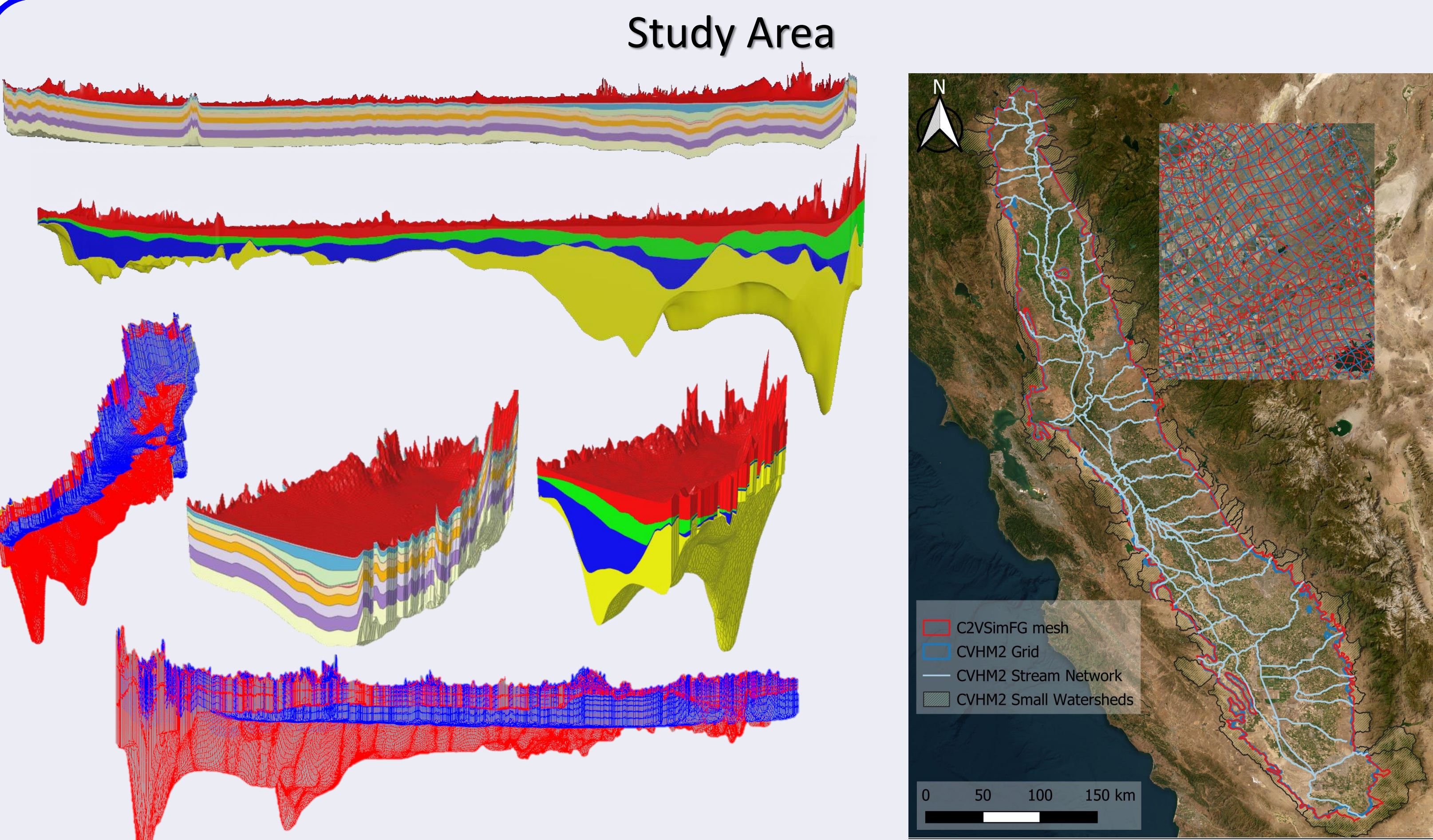
CVHM2: Central Valley Hydrologic Model 2 (MODFLOW-OWHM)*

- Finite difference method
- 20355 active cells
- Element size 1 square mile
- 13 layers
- Time span: Apr 1961 - Sep 2019
- 702 Monthly steps (2 periods)
- FARM package
- 24 Crop Categories
- 271 Stream segments
- 4043 Stream cells

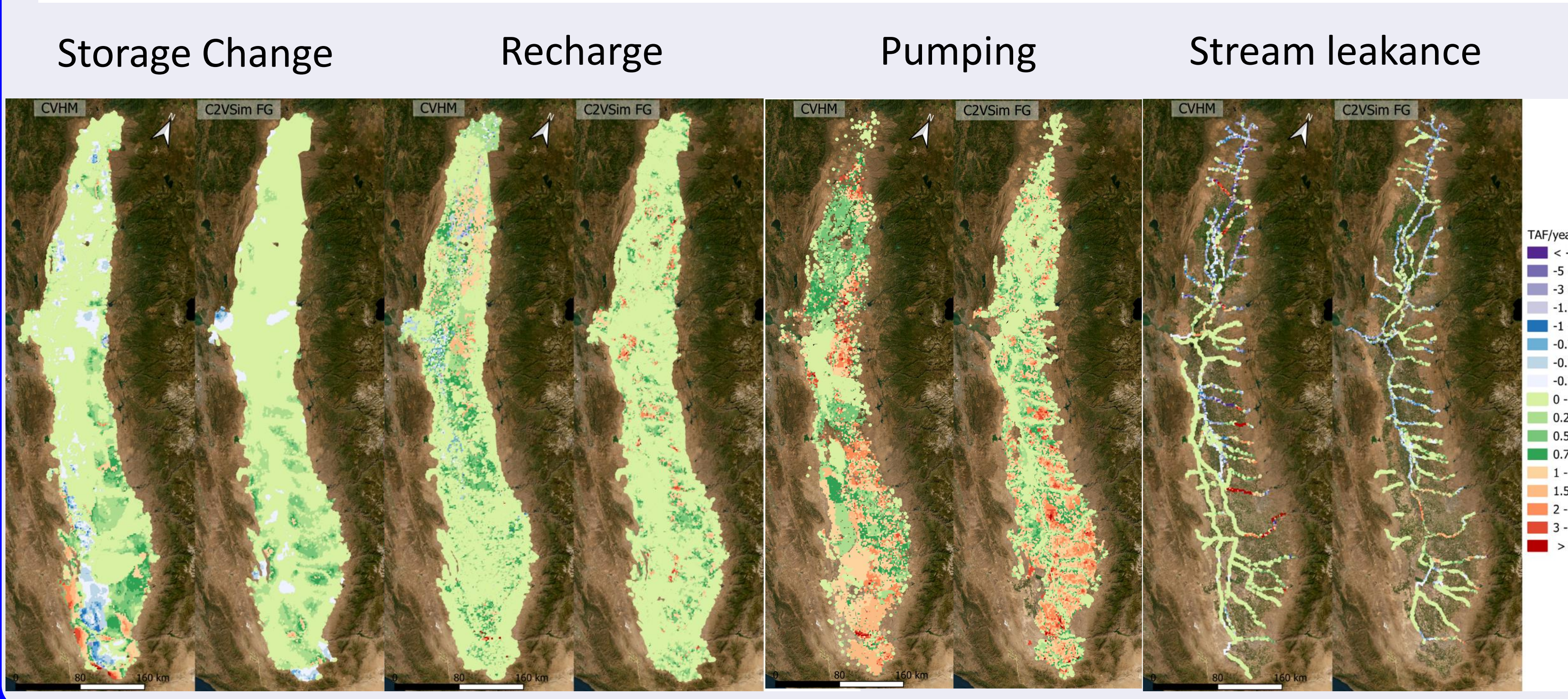
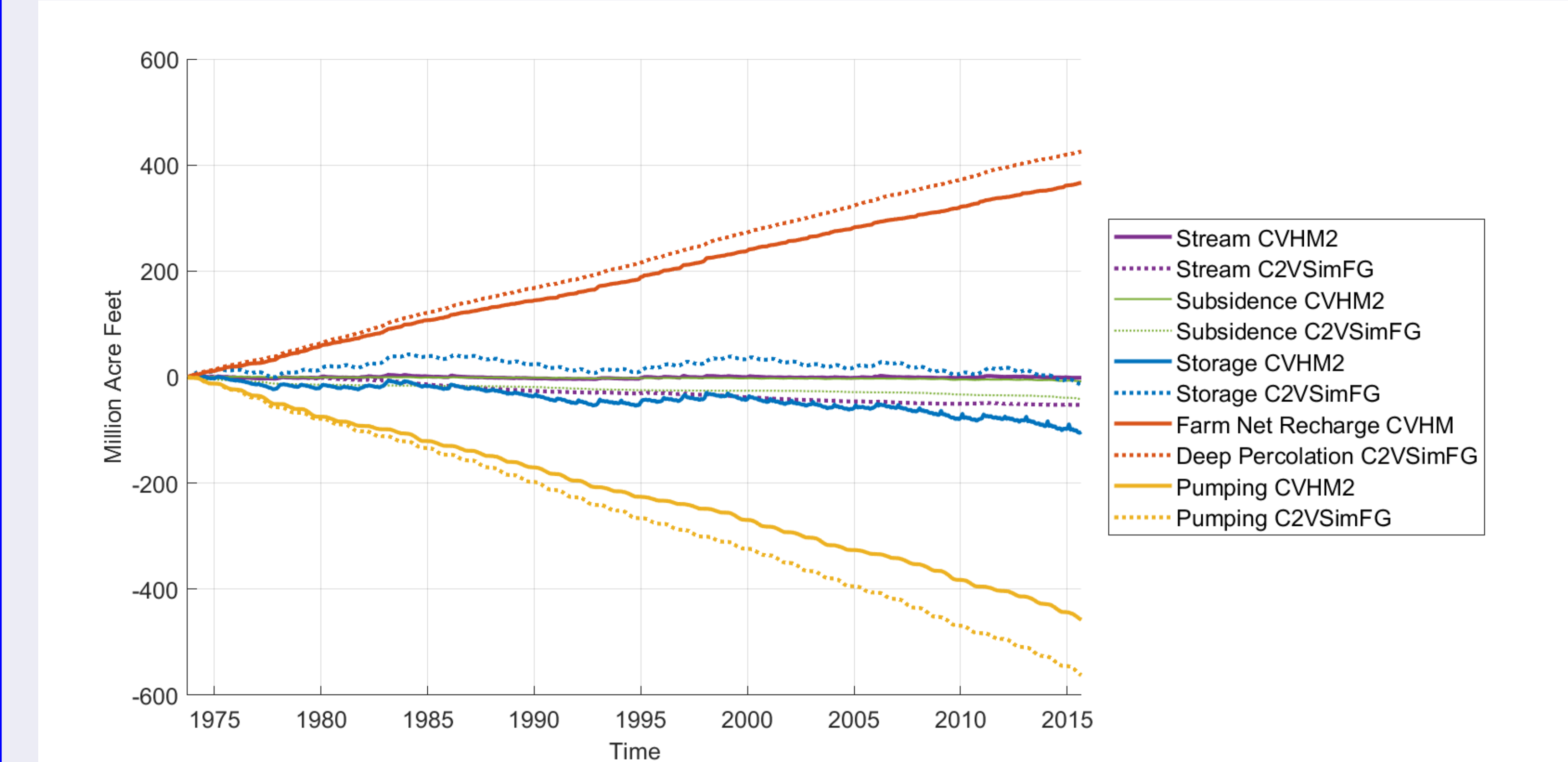
* prerelease version

C2VSIM: California Central Valley Groundwater-Surface Water Simulation Model (IWFM 2015)

- Finite element method
- 32537 elements, 30179 nodes
- Element Size 1-3 square miles
- 4 layers + 4 (aquifers)
- Time span: Oct 1973 - Sep 2015
- 504 Monthly steps
- IDC
- 21 Crop categories
- 110 Stream Reaches, 4634 nodes

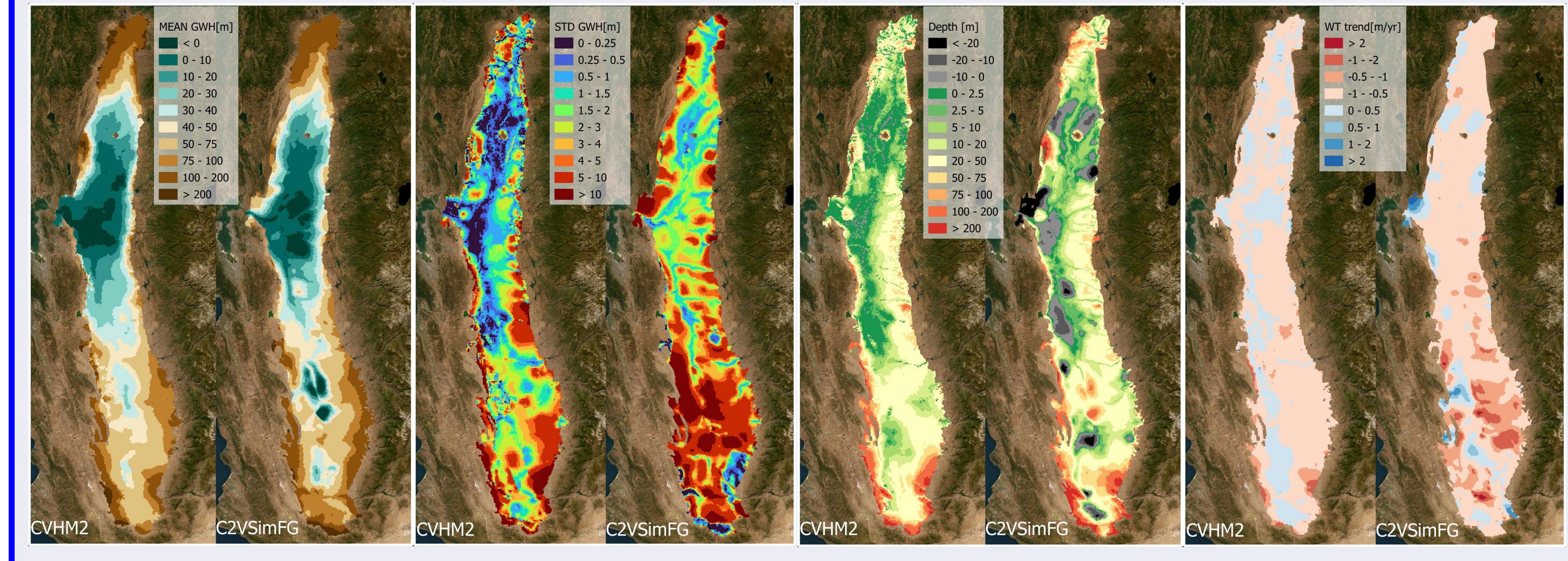


Groundwater Budget - Cumulative Spatial

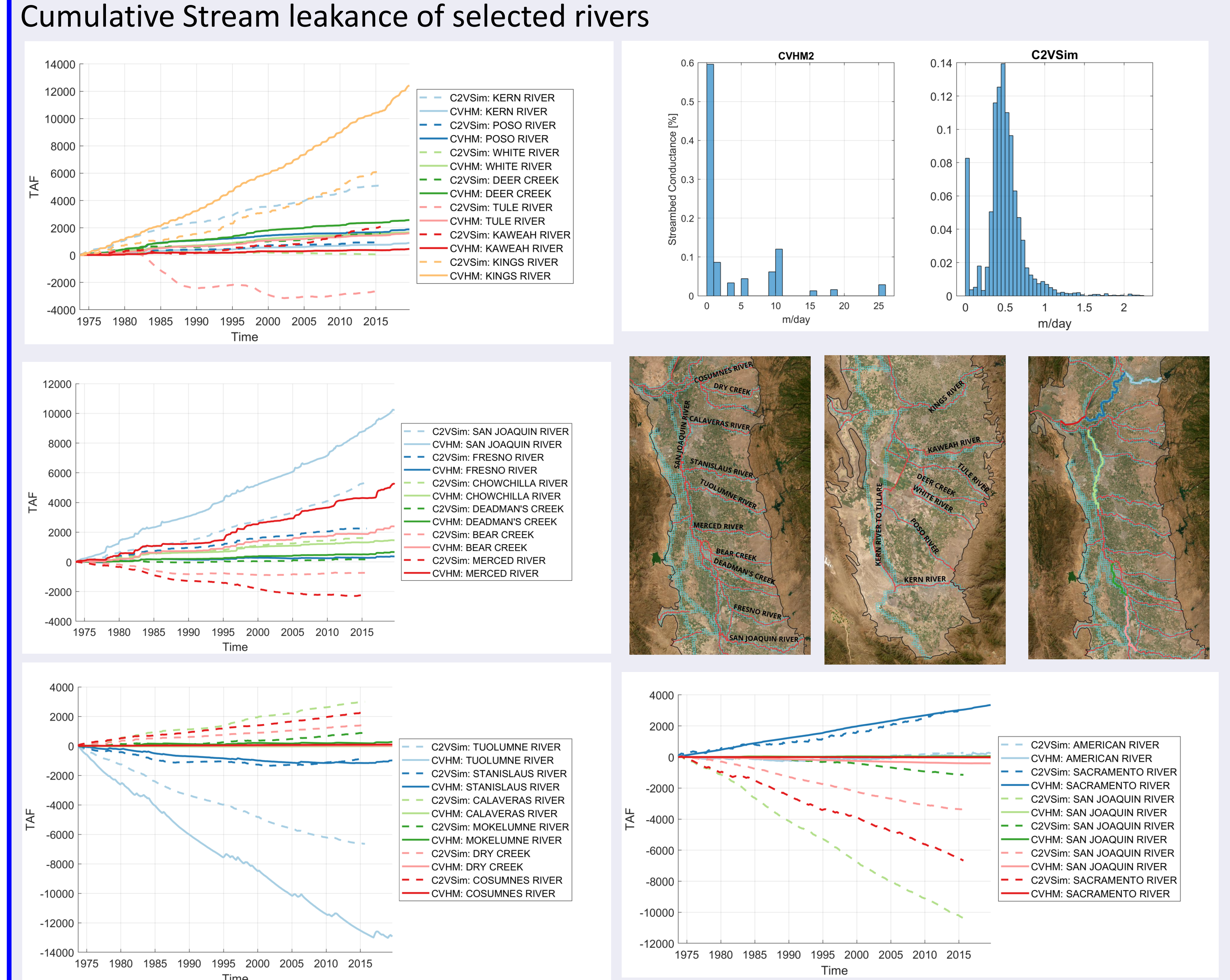


Groundwater Head Comparison

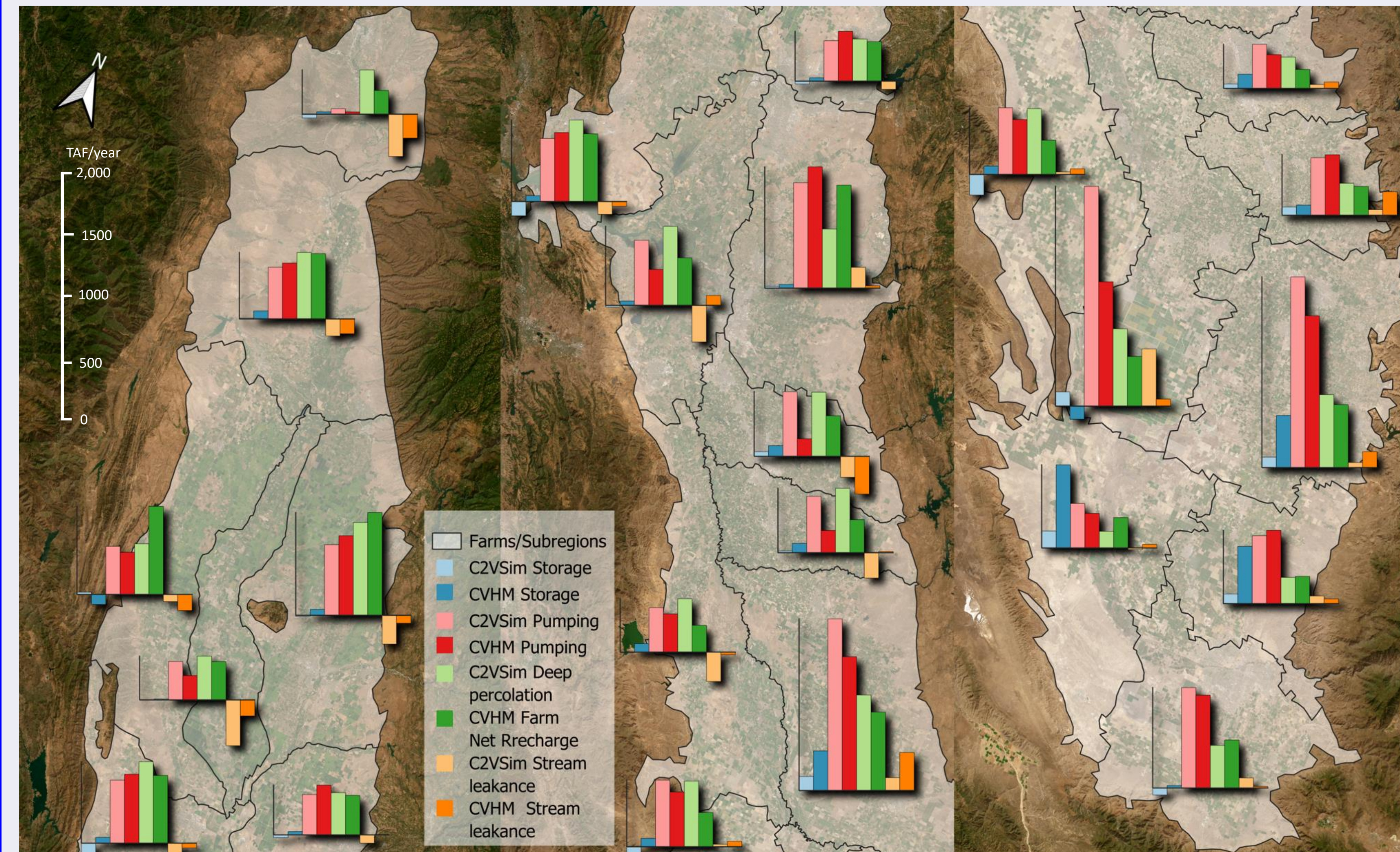
- Monthly mean groundwater head (GWH) and monthly standard deviation
- Mean Unsaturated Zone Depth between 2005 – 2015
- Water Table(WT) trend of the yearly mean GWH amsl of the last 20 years of the simulation



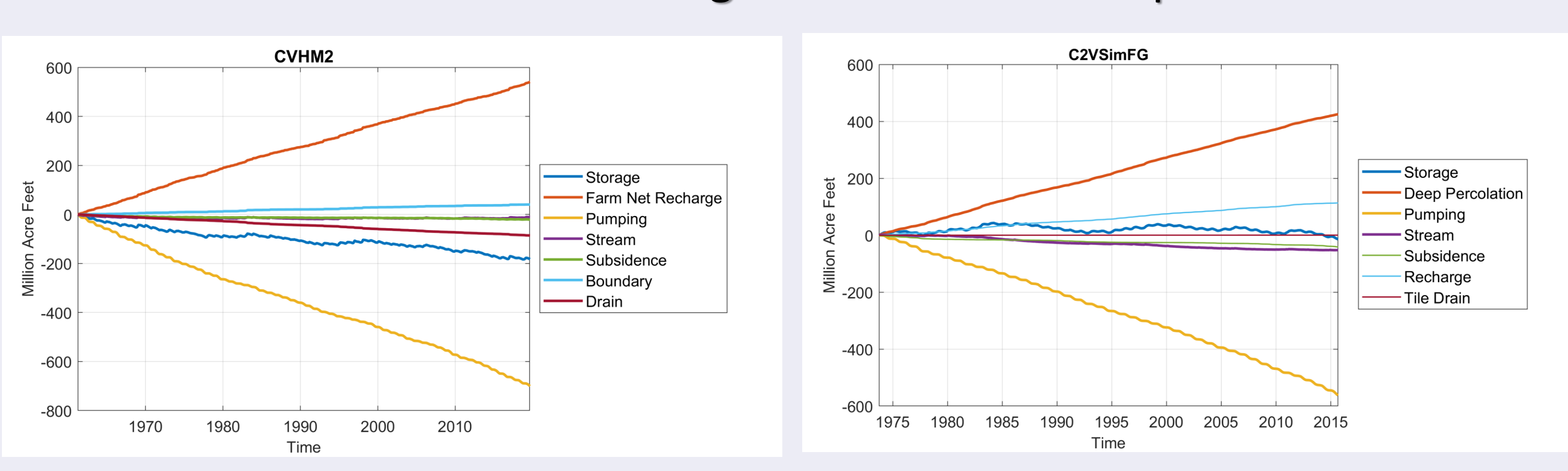
Stream leakage comparison



Groundwater budget by Farm/Subregion



Groundwater Budget - Cumulative Temporal



Conclusions

- We present a comparison of two integrated hydrologic models e.g. Modflow-OWHM and IWFM2015.
- Despite the methodological and structural differences, the two model agree at a basin level on many important factors such as estimated pumping, groundwater recharge, hydraulic head
- At a local scale, the two models have an overall good agreement for most of the subregions/Farms, yet on a few occasions the estimated groundwater budgets are substantially different.

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